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ABSTRACT

This course is one of four in a solar systems and energy management program developed by the Bergen County Vocational-Technical Schools to help tradespeople (heating, ventilation, and air conditioning mechanics; plumbers; and electricians) to develop an awareness of alternate energy sources and to gain skills in the areas of solar installations and energy evaluation and management. The format of the course is a combination of lectures, visual presentations, and shop sessions. Upon completion of the course, students will be expected to understand the necessity for following proper start-up procedures for a solar system and will gain the ability to perform a start-up. Students will also be expected to troubleshoot a malfunctioning solar system, to make necessary repairs, and to perform preventive maintenance. Following introductory materials that explain the purpose and conduct of the course, the course syllabus contains six units. Each unit consists of an outline, objectives, note to the instructor, and/or shop session notes. The units cover the following topics: introduction and orientation, system start-up, mechanical maintenance, electrical maintenance, solar system troubleshooting, and troubleshooting solar back-up systems. The competencies to be acquired by students are listed at the end of the syllabus. (KC)

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BERGEN COUNTY VOCATIONAL-TECHNICAL SCHOOLS
200 Hackensack Avenue
Hackensack, New Jersey 07601

COURSE SYLLABUS

COURSE TITLE:

SOLAR TROUBLESHOOTING AND MAINTENANCE

U.S. DEPARTMENT OF EDUCATION
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March, 1983

ENERGY TECHNOLOGY DEPARTMENT

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Bergen County Vocational-Technical Schools
200 Hackensack Avenue
Hackensack, New Jersey 07601

COURSE SYLLABUS

COURSE TITLE: SOLAR TROUBLESHOOTING AND MAINTENANCE

LENGTH OF COURSE: 36 HOURS

SUGGESTED TEXT:

COURSE DESCRIPTION: This course serves as a follow-up for students who have completed, at a minimum, Introduction to Solar Energy Systems and Solar Active Systems. Major course topics include proper start-up procedure for an installed solar system, troubleshooting of a malfunctioning solar system, and routine preventive maintenance. The class format is a combination of lecture and shop sessions with instructor demonstrations and visual aids.

OVERVIEW OF THE ADULT ENERGY TECHNOLOGY PROGRAM

The Energy Technology Program for adults consists of technical training courses offered exclusively by the Bergen County Vocational-Technical Schools and a college-credit certificate program offered in conjunction with Bergen Community College.

Technical training courses offered through this school include Heating, Air Conditioning and Refrigeration, Oil Burner Technician Training, Blueprint Reading and Estimating for the HVAC Trades, Sheet Metal Layout and a new program in Solar Systems and Energy Management. In addition to these part-time technical training programs, the School operates a full-time, intensive training program for HVAC mechanics.

The new solar program is designed for tradespeople (HVAC mechanics, plumbers, electricians) to help them develop an awareness of alternate energy sources such as solar and to gain skills in the areas of solar installations and energy evaluation and management.

INTRODUCTION TO COURSE

The purpose of this course is to provide training to students in order to develop the technical capability required to repair and maintain a solar system.

The requirements for entrance into this course include successful completion of Introduction to Solar Energy Systems and Solar Active Systems or at least two years of experience as a solar installer.

The course prepares the student to understand and practice safe troubleshooting techniques and basic preventive maintenance. Training is accomplished through class lectures, visual aids, and hands-on experience gained from participation in (6) shop sessions.

Upon completion of the course, students will be able to understand the necessity for following proper start-up procedures for a solar system and will gain the ability to correctly perform a start-up. The student will also be able to effectively troubleshoot a malfunctioning solar system and to make necessary repairs. Students will also acquire proficiency in preventive maintenance procedures.

INSTRUCTIONAL METHODS

A combination of instructional methods will be utilized. Lecture will be supplemented by demonstrations, teacher-prepared handouts and visual aids, including slides, 16mm film and/or overhead projections as may be appropriate to the instructional unit. "Hands-on" shop sessions are designed to reinforce theory, to provide students with job-simulated experiences, and to expose students to equipment utilized in the field.

CLASS REQUIREMENTS

Students will be expected to come prepared for class by completing reading and other homework assignments. Students will be expected to take notes in class and to study in a manner conducive to successful performance on tests and quizzes.

STUDENT EVALUATION AND GRADING

The exact procedure for grading will be the decision of the individual instructor; however, the following guidelines will be adhered to:

1. A written midterm and final examination covering all material presented in the course will be administered and evaluated.
2. An average of six quizzes will be administered and evaluated periodically during the course.
3. Shop/laboratory exercises will be evaluated.
4. Attendance and attitude will be evaluated.
5. Final grade will reflect the aggregated evaluation of the above.

UNIT I: INTRODUCTION AND ORIENTATION

Unit Outline:

A. Overview of the Adult Energy Technology Program
B. Introduction to Course
    1. Description and purpose of course
    2. Pre-requisite requirements
    3. Projected outcomes for students who successfully complete course
        a. Anticipated learning
        b. Job preparation
    4. Class requirements
    5. Instructional methods
    6. Student evaluation and grading policy
C. Safety Regulations (as per district policy)
    1. Proper use of shop equipment
    2. Safety goggles
    3. Clothing
    4. Body mechanics
    5. Emergency procedures in case of accident
D. Fire Information
    1. Fire extinguishers
    2. Fire drills and safe exit from building
E. Smoking Policy
F. General Information for Students
        a. Parking
        b. Book purchase
        c. Breaks
        d. Class cancellation
        e. Certificate of course completion

Unit Objectives:

Upon completion of this unit, the student will be able to:

1. Develop an overview of the adult Energy Technology program.

2. Develop a clear understanding of the course, including its purpose, requirements for entrance, projected outcomes, class requirements, methods of instruction, evaluation and grading.

3. Explain and demonstrate safe use of shop equipment.

4. Explain when and why safety goggles are to be utilized.

5. Identify acceptable and unacceptable clothing as related to shop safety.

6. Define the term "body mechanics."

7. Describe the benefits of using good body mechanics in the shop and demonstrate same.

8. Explain the procedure to be followed in case of accident.

9. Identify any combustible materials in the shop and select the proper extinguishing agent(s).

10. Explain the color and letter markings on various fire extinguishers.

11. Demonstrate the proper handling and safety precautions to be used with extinguishers.

12. Demonstrate the fire emergency procedure of the school.

13. Identify the smoking regulations of the school.

14. Review school policy in terms of parking, class breaks, purchase of books, cancellation of class, and certificate requirements upon completion of course.

NOTE TO INSTRUCTOR:

Consult the district Safety Education Program manual (Fall, 1981) for policy and practice relative to general safety regulations, fire information, and smoking policy.

UNIT II: SYSTEM START UP

Unit Outline:

A. Charging the system
B. Balancing Flow rates
C. Adjusting controls
    1. Changeover theromstats
    2. Differential controls
D. Checking security of collector mounting
E. Leak testing
F. Testing Drain-Back Feature
G. Testing water hardness and pH

Unit Objectives:

Upon completion of this unit, the student will be able to:

1. Properly charge a solar loop with water or transfer fluid.

2. Understand the theory of flow rate balancing and be able to adjust same.

3. Describe the different types of solar controls and be able to properly adjust them.

4. Identify a properly mounted collector and be able to secure a deficient mount.

5. Test a solar loop for water or air leaks and repair same.

6. Perform a test of a solar system's drain-back or drain-down feature.

7. Describe the problems of hard water or negative and positive pH, and be able to compensate for these problems.

Unit Shop Session:

Students will start up a solar system including system charge proper balancing of collector flow, adjustment of controls, and testing of the system's shut-down process.

UNIT III: MECHANICAL MAINTENANCE

Unit Outline:

A. Corrosion Prevention
    1. Proper piping
    2. Balanced water in system
    3. Soft water in system
B. De-scaling collectors and piping
    1. Chemical cleaning
    2. Brush cleaning
C. Periodic check for Corrosion and Scale Build-up
    1. Inspection of corners on tanks
    2. Visual check of pipes
    3. Strainer check
D. Glazing Maintenance
    1. Cleaning
    2. Replacement of broken glazing
    3. Inspection of weep hole
E. Pump maintenance
    1. Oiling
    2. Analysis and test of pump speed
    3. Repair of Defective Seals
    4. Replacement of Defective Bearings
F. Blower Units
    1. Adjustment of Belts
    2. Adjustment of Blower CFM
    3. Filter changes
    4. Coil cleaning
    5. Oiling of Bearings
G. Air Duct Maintenance
    1. Oiling of Dampers
    2. Adjustment of Dampers
    3. Duct Cleaning
    4. Inspection and repair of duct insulation
H. Piping Maintenance
    1. Repair of Leaks
    2. Inspection and repair of pipe insulation
    3. Inspection of pipe supports

Unit Objectives

Upon completion of this unit, the student will be able to:

1. Explain various ways of preventing corrosion in solar systems including procedures for proper installation and water treatment.

2. Describe methods of de-scaling collectors and piping.

3. Define the purpose of periodic checks for scale and corrosion in solar systems.

4. Describe the procedure for repair and cleaning of collector glazing.

5. Identify the highlights of correct pump maintenance and repair.

6. Outline the procedure for routine maintenance and repair of blower units and coils.

7. Explain the routine maintenance procedure for ductwork and dampers.

8. Describe the methods of repair for piping leaks and maintenance for insulation and pipe supports.

Unit Shop Sessions:

A. Students will practice skills that relate to liquid solar maintenance such as testing and treatment of water to prevent corrosion, repair of pumps, and maintenance and replacement of collector glazing.

B. Students will practice repair and maintenance on air ducts, dampers, blower units, and coils.

UNIT IV: ELECTRICAL MAINTENANCE

Unit Outline:

A. Main Power Supply
    1. Fuses or circuit breakers
    2. Proper phasing and voltage
    3. Tightness on splices and connection
B. Wiring
    1. Conduit condition
    2. Wire temperature
C. Controls
    1. Proper set points
    2. Adjustment of differential control
    3. Tightness of thermisters
D. Pumps
    1. Replacement motors
    2. Repair of motor start switch or speed switch
    3. Adjustment of amperage draw
E. Blowers
    1. Repair or replacement of motors
    2. Overload protection
    3. Adjustment of amperage draw

Unit Objectives:

Upon completion of this unit, the student will be able to:

1. Identify the proper incoming voltages and be able to check for possible hazards or loose connections.

2. Describe typical wiring configurations and possible problems relating to undersized wiring or non-watertight conduit.

3. List the different types of controls and proper set points for controls.

4. Give the procedure for repairing and replacing pump motors and adjusting amperage draw for a pump.

5. Describe how to repair and replace a blower motor and how to adjust amperage draw.

6. Explain the function of overload protection.

Unit Shop Session:

Students will practice testing of incoming voltages, checking for loose connections, adjusting controls and testing their functions, and repairing motors for pumps and blowers.

UNIT V: SOLAR SYSTEM TROUBLE SHOOTING

Unit Outline:

A. Electrical Problems
    1. Incoming power
    2. Transformers
B. Control Problems
    1. Relays
    2. Temperature controller
    3. Differential controller
    4. Thermisters
C. Fluid Flow Problems
    1. Defective pumps
    2. Unbalanced flow
    3. Check Valves
    4. Solenoid valves
D. Heat Distribution Problems
    1. Pump or blower malfunctions
    2. 3-way valves
    3. Dampers
E. Overheating Problems
    1. Insufficient circulation
    2. Defective controls
    3. Defective pump or blower

Unit Objectives:

Upon completion of this unit, the student will be able to:

1. Differentiate between proper and improper incoming voltages to solar units.

2. Describe the proper function of various controls for the solar system and how to repair or replace a defective unit.

3. List various fluid flow problems and describe solutions to these problems.

4. Explain what a heat distribution problem is, how it can occur, and describe the procedure for restoring a system to proper function.

5. Identify an overheating problem in a water or air-cooled collector and adjust the system to eliminate the problem.

Unit Shop Session:

Students will practice identification and troubleshooting of electrical problems on a solar trainer, as well as adjusting collector flow on live systems.

UNIT VI: TROUBLESHOOTING SOLAR BACK-UP SYSTEMS

Unit Outline:

A. Changeover controls
    1. Electric
    2. Pneumatic
B. Back-up Boilers
    1. Gas fired
    2. Oil
    3. Electric
C. Back-up Furnaces
    1. Gas
    2. Oil
    3. Electric Duct Heater
    4. Electric Baseboard
    5. Wood Stove
D. Lock-Out Controls
    1. Proportional temperature control
    2. Temperature Lock-out

Unit Objectives:

Upon completion of this course, the student will be able to:

1. Identify the types of changeover controls used to start up various back-up systems and explain how they operate.

2. Describe the different types of back-up units available and the benefits of each type.

3. Explain the principles of operation of the different types of back-up furnaces and how each can work with a solar system.

4. Describe how a properly functioning temperature lock-out or proportional temperature control will save energy.

Unit Shop Session:

Using trainers and live systems components, students will troubleshoot a solar system, review troubleshooting principles for conventional HVAC systems, and develop a working understanding of how a conventional HVAC system is a vital part of a solar system.

COURSE PROFICIENCIES

Note: Proficiencies (sometimes referred to as "tasks" or "competencies" in the field of education) are defined as those skills acquired by a student that make he or she employable in a vocational or technical trade. Proficiencies are interpreted to mean applied, practical knowledge, i.e., those skills for which an employer would be willing to pay wages. While unit objectives may reflect learning theory as well as practical skills, the proficiencies refer exclusively to salable skills.

Students who complete this course are expected to achieve the following proficiencies:

1. Work safely in a simulated work environment by consistently demonstrating proper safety measures with regard for themselves, for other people, and for equipment and tools.

2. Properly start-up a solar system after the installation of same.

3. Calculate and balance the flow rates for both air and water-cooled collectors.

4. Identify a defect from a faulty installation and provide necessary measures to restore the unit to proper function.

5. Perform a leak test for a solar system and correctly repair any leaks that are found.

6. Understand ways of preventing corrosion and scale build-up and how to remove corrosion and scale when found in a system.

7. Describe the procedure for repairing a pump or blower unit.

8. Explain the procedure for troubleshooting a malfunctioning system, including electrical and control problems, as well as fluid transfer problems.

9. Understand how preventive maintenance can reduce downtime of equipment and maximize solar gain.

10. Identify the various types of back-up systems used to assist a solar system and be able to troubleshoot the changeover controls.